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In re patent application of

Bryan Bees et al.

Corres. to DE-Patent No. 101 08 254.1

For: OPTICAL VIEWING DEVICE HAVING AN APPARATUS FOR PARTIAL
REDUCTION OF THE ILLUMINATION INTENSITY

TRANSLATOR'S DECLARATION

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I further declare that all statements made in this declaration of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful, false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful, false statements may jeopardize the validity of legal decisions of any nature based on them.

December 05, 2003

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**OPTICAL VIEWING DEVICE HAVING AN APPARATUS FOR PARTIAL
REDUCTION OF THE ILLUMINATION INTENSITY**

The invention concerns an optical viewing device having an apparatus for partial reduction of the illumination intensity, for example a surgical 5 (stereo)microscope having an eclipse filter. An "eclipse filter" is understood to be a spectral filter in the illuminating beam path which partially reduces the illumination intensity in a specific light wavelength region.

Reduction of the illumination in a specific spatial region of the specimen, by means of a stop that can be swung into and out of the illuminating 10 beam path, is being more and more often utilized in a variety of applications because light-sensitive surfaces of the specimen can thereby be protected from excessively strong radiation.

These stops are generally configured as stops that can be swung in or out, providing complete and/or partial darkening of the illuminating beam path in a 15 specific spatial region.

DE 93 01 448 U discloses a filter system having individual filters possessing different diameters, in which system a partial darkening is possible in specific spatial regions. Said darkening is not wavelength-dependent in the visible light region between 400 and 700 nm. Reference is made only to the fact that a greater 20 darkening can take place in the wavelength region below 400 nm.

DE 88 08 871 U makes known a diffusion plate for slit lamp devices which creates a preferred direction in the scattering characteristic.

In addition, a light trap having a centrally darkened region is described in U.S. Pat. No. 4,715,704.

The inventor has recognized that the known systems are disadvantageous in the following respects:

- a) The reduction in light intensity is accomplished either in binary fashion (i.e. the reduced-light specimen region either appears dark to the user or is visible at full brightness), or there is a graduated filter effect but it is not optimized in terms of light color; this can therefore have negative effects on a specimen, for example on a patient's eye.
- b) In order to make the reduced-light region visible in true color to the viewer, it is necessary to switch out the stop, which means full (and usually specimen-damaging) illumination of the specimen.
- c) Because of the fixed positioning of the stop in the illuminating beam path, the shape and/or the attenuated illuminating beam path cannot be varied.
- d) Damage to the specimen, for example to the patient's eye, usually does not occur in similarly hazardous fashion over the entire range of light wavelengths, but rather only in a specific wavelength region, for example from 420 nm to 470 nm and below 400 nm.

It is therefore the object of the invention to create an apparatus which optimally protects the specimen's sensitive region, for example the patient's eye, and eliminates the aforementioned disadvantages, regardless of

- 20 • the three-dimensional shape of the specimen's sensitive region, or
- the intensity at which injury occurs to the region of the specimen to be protected.

This object is achieved by the use in the illuminating beam path of a spectral filter which varies its filter effect in graduated or stepless fashion, for example as a 25 function of distance from the center axis of the filter, and

- i) which is of a defined spatial configuration, for example possesses the shape of the specimen to be protected; and/or
- 5 ii) whose absorption and/or reflection is defined, according to the present invention, as desired between e.g. 0% and 90%, in particular in the light wavelength region between 420 and 470 nm; and/or
- 10 iii) whose absorption and/or reflection is, according to the present invention, of wavelength-dependent configuration, for example in particular in the light wavelength region between 420 and 470 nm, by means of thin films; and/or
- iv) which is spatially displaceable in its utilization plane and/or utilization axis and/or extension; and/or
- v) which can be divided into fields having, according to the present invention, different absorption and/or reflection properties as defined in ii) which exhibit graduated or stepless transitions; and/or
- 15 vi) which, in a specific further developed embodiment, can be configured e.g. as an LCD and/or as an electrochromic film and can thus be controlled electronically.

With the use as described above of a spectral filter in the illuminating beam path of an optical viewing device, the improvements listed below are achieved in the following steps:

- 20 • As a result of the light wavelength-dependent darkening of the specimen region to be protected, the specimen is protected from injury by means of optimized light colors.
- As a result of the incomplete darkening of the specimen region to be protected, darkening is performed not in binary fashion but rather, for 25 example, from 0% to 50%. The darkened region thus remains continuously visible to the viewer in a specific non-hazardous light wavelength region.

- If the specimen surface to be protected is not injured below a specific light intensity, the darkening is, in a manner known per se, defined down to that intensity.
- If the specimen surface to be protected can be injured only by specific wavelength regions, the reduction is then confined to that wavelength region – but in locally specific fashion.
- As a result of the division according to the present invention of the spectral filter into different regions, different absorption profiles (intensity reduction as a function of wavelength) can be generated.
- 10 • As a result of the spatial displaceability of the spectral filter in its utilization plane and/or utilization axis, the protected region can be varied to a specific extent.
- As a result of the use according to the present invention of thin films, it is possible to create any desired absorption profiles (intensity reduction as a function of wavelength) for the light.
- 15 • As a result of the use according to the present invention of an LCD and/or electrochromic films, any desired absorption surfaces and/or absorption profiles (intensity reduction as a function of wavelength) can be created in electronically controlled fashion.
- 20 Although reference is made in the above text to a surgical microscope, the invention is nevertheless not limited thereto but rather is also open to other users of optical devices with a partial reduction in the illumination intensity and/or specimen irradiation (e.g. projectors, video and photographic cameras, etc.).

DESCRIPTION OF THE DRAWINGS

The Figures and the Parts List are, together with the features described in the Claims, integral constituents of the disclosure of this Application.

- The Figures are described in continuous and overlapping fashion. Identical
5 reference characters denote identical components; reference characters having different indices indicate functionally identical components.

FIG. 1 symbolically shows the overall construction of an optical viewing device, for example of a surgical stereomicroscope, is a light source 1, for example a lamp or the end of an optical waveguide; an illuminating beam path 2; an illuminating optical system 3a, 3b; a spectral filter 4 according to the present invention; a main objective 6; a light-intensity reduced illuminating beam path 5, for example to an eye, symbolically comprising a pupil 7, iris 8, and eyeball 9. Also symbolically depicted are specimen beam path 10, eyepiece 11, and viewer 12. As a variant, spectral filter 4 can also be arranged between light source 1 and illuminating optical system 3.
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FIG. 2 schematically shows the eye, comprising pupil 7, iris 8, and eyeball 9, in a plan view. The profile of intensity reduction 24 for a specific wavelength lambda 0 is depicted as a function of light-intensity reduced region 21 (x, y) resulting from spectral filter 4.

20 FIG. 3 shows a possible profile of the light intensity reduction as a function of the wavelength lambda, with a specific light-intensity reduced wavelength region 22 and a specific wavelength lambda 0 (cf. reference character 23).

FIG. 4 schematically shows electronic controller 25 for a spectral filter 4, which can be configured e.g. as an electrochromic film or LCD.

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MODE OF OPERATION

Illuminating beam path 2 emerging from light source 1 is reduced in intensity in a specific spatial region 5, in a manner dependent on the light wavelength, by way of an illuminating optical system 3a, 3b and a spectral filter 4 located therebetween. The location of filter 4 can also be, unlike in FIG. 1, between light source 1 and illuminating optical system 3a, 3b. As a result, the intensity is reduced by means of spectral filter 4 over a specific light-sensitive spatial specimen region (x, y), for example the retina/cornea in the case of an eye. Spectral filter 4 is configured in such a way that the reduction is accomplished in a specific wavelength region 21, for example from 420 nm to 470 nm, and/or assumes a specific value that is, for example, between 0% and 90%. The remaining illuminated region that was not attenuated experiences the entire light output and/or a wavelength-dependent light output. The assemblage makes it possible, by way of the shape of spectral filter 4, to configure the light-reducing illumination region (x, y) arbitrarily in space (FIG. 2); and by a displacement of the spectral filter and/or a displacement of illuminating optical system 3a, 3b to make the spatial extension (x, y) larger or smaller to a certain extent.

The absorption properties (FIG. 3) of spectral filter 4 make possible, according to the present invention, a specific reduction in the light intensity as a function of the wavelength lambda, or a difference in transparency as a function of the local region of spectral filter 4 (FIG. 2).

A development of the invention consists in the fact that the spectral filter is configured as an LCD and/or an electrochromic film that is electronically controlled 25. This allows the spatial extension (x, y) and/or intensity and/or wavelength of light-reducing region 21 to be made variable.

LIST OF REFERENCE NUMBERS

- 1 Light source (lamp or end of an optical waveguide)
- 2 Illuminating beam path
- 3, 3a, 3b Illuminating optical system
- 4 Spectral filter
- 5 Light-intensity reduced illuminating beam path
- 6 Main objective
- 7 Pupil
- 8 Iris
- 9 Eyeball
- 10 Specimen beam path
- 11 Eyepiece
- 12 Viewer
- 21 Light-intensity reduced illumination region
- 22 Light-intensity reduced wavelength region
- 23 Lambda 0
- 24 Intensity reduction (Int 0)
- 25 PC control of electrochromic film and/or LCD

PATENT CLAIMS

1. A device for partial reduction of the light intensity of an illumination, for example in a microscope having an illuminating beam path, a main objective, a light source, and a spectral filter, characterized in that the spectral filter (4) is configured such that in spatial illumination regions (21) differing from one another, it reduces the light intensity in different wavelength regions (22) to a specific extent (intensity reduction 0) (24).
2. The device as defined in Claim 1, characterized in that at least one region of the spectral filter (4) absorbs a specific wavelength lambda 0 (23) that lies, for example, in the region from 420 to 470 nm and/or below 400 nm, respectively in the region injurious to the retina/cornea.
3. The device as defined in one of the foregoing claims, characterized in that the absorption edges of at least one of the light-intensity reduced wavelength regions (22) are of flat or steep configuration.
4. The device as defined in one of the foregoing claims, characterized in that the spectral filter (4) has a profile that has light-intensity reduced wavelength regions (22) differing from the inside outward, for example on the inside is reduced by 50% 420 to 470 nm and on the outside exhibits no reduction over the entire visible light spectrum.
5. The device as defined in Claim 1, characterized in that the spectral filter (4) has a specific light intensity reduction Int 0 (24) that lies, for example, between 0 and 90%, in particular in the wavelength region from 420 to 470 nm.
6. The device as defined in Claim 1, characterized in that the spectral filter (4) exhibits a profile that has different light intensity reductions Int 0 (24) in

different wavelength regions (22), which are for example 90% on the inside and 0% on the outside.

7. The device as defined in Claim 1, characterized in that the spectral filter (4) has a disk-like shape with a variable light-intensity reduced illumination region (21).
8. The device as defined in Claim 1, characterized in that the spectral filter (4) can be slid and/or pivoted in or out mechanically.
9. The device as defined in Claim 1, characterized in that the spectral filter (4) can be displaced spatially in its utilization plane and/or utilization axis.
10. The device as defined in Claim 1, characterized in that the spectral filter (4) is arranged tiltably, so that a variation of the filter properties in a specific lightwave region is possible.
11. The device as defined in one of the foregoing claims, characterized in that the spectral filter (4) is configured such that the light-intensity reduced illumination region (21) can be made larger or smaller by way of a displacement in the axial direction, separately and/or in combination with the illuminating optical system (1, 3).
12. The device as defined in one of the foregoing claims, characterized in that the spatial displaceability of the spectral filter (4) and/or its ability to be switched in and out can be controlled electronically or manually.
13. The device as defined in one of the foregoing claims, characterized in that the spectral filter (4) is configured as a thin film and/or as an LCD and/or as an electrochromic film.

14. The device as defined in one of the foregoing claims, characterized in that the intensity reduction Int 0 (24) and/or the wavelength lambda 0 (23) and/or the reduced-light wavelength region (22) are electronically controllable (25).
15. The device as defined in one of the foregoing claims, characterized in that the spatial displacement of the spectral filter (4) and/or its ability to be switched in or out can be coupled via a control circuit to the imaging of the specimen.

ABSTRACT

The invention concerns an optical viewing device having an apparatus for partial reduction of the illumination intensity, for example a surgical (stereo)microscope. By means of a spectral filter (4) arranged in the illuminating beam path (2), the illumination intensity on the specimen (x, y), for example an eye, is reduced. According to the present invention, the reduction is accomplished in intensity-dependent and/or wavelength-dependent fashion.

(FIG. 1)